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A possible interrelation between Earth rotation and climatic variability at decadal time-scale

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ABSTRACT

Using multichannel singular spectrum analysis (MSSA) we decomposed climatic time series into principal components, and compared them with Earth rotation parameters. The global warming trends were initially subtracted. Similar quasi 60 and 20 year periodic oscillations have been found in the global mean Earth temperature anomaly (HadCRUT4) and global mean sea level (GMSL). Similar cycles were also found in Earth rotation variation. Over the last 160 years multi-decadal change of Earth's rotation velocity is correlated with the 60-year temperature anomaly, and Chandler wobble envelope reproduces the form of the 60-year oscillation noticed in GMSL. The quasi 20-year oscillation observed in GMSL is correlated with the Chandler wobble excitation. So, we assume that Earth's rotation and climate indexes are connected. Despite of all the clues hinting this connection, no sound conclusion can be done as far as ocean circulation modelling is not able to correctly catch angular momentum of the oscillatory modes.

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1. Introduction

In the last decades the International Panel on Climate Changes (IPCC) has published several reports, concerning climate variability [1]. Many observations have been presented and analysed, including Earth's temperature and global sea level (SL) changes, glacial melting, increase in concentration of greenhouse gases. Global warming trends are clearly seen in these data (Fig. 1) and their prediction using complex models of ocean and atmosphere dynamics is a major matter of IPCC concern. While these models include many factors, they still badly reproduce the so-called "natural variability", mostly composed of quasi 60- and 20-year variations of temperature (up to 0.3 °C) and SL (up to 30 mm) during the last 160 years. Such variations (Fig. 1) are evidenced by the data representing the global Earth's temperature anomaly (HadCRUT4) and the global mean sea level (GMSL) [2,3], sea surface temperature (HadSST) [4–9], and are shown in Fig. 2 after trends have been removed. The interpretation of these periodicities is not well understood. For example, 70-year temperature variations are usually related to the Atlantic Multi-decadal Oscillation (AMO) propagating in the northern Atlantic, influencing the continents of the Northern Hemisphere [4], and teleconnected with the Pacific Decadal (PDO) and Arctic (AO) oscillations. The quasi 20-year variability is inherent in the Indian and Pacific oceans [8]. These variations are often related to natural oscillatory modes of atmosphere, such as El Nino Southern Oscillation (ENSO) (composed of a few quasi-periodicities lying between 2 and 8 years) and North Atlantic Oscillation (NAO). The aim of this paper is to reassess such a link and deepen its meaning, by paying attention, at the same time, to the similarities between the climatic processes and Earth rotation changes, already noticed in references [10–12].

2. The quasi 20 year and 60 year climatic cycles

The above mentioned time series are decomposed by multichannel singular spectrum analysis (MSSA), for it allows to extract their periodic components with changing amplitudes, and their trend, as well as to suppress the noise.

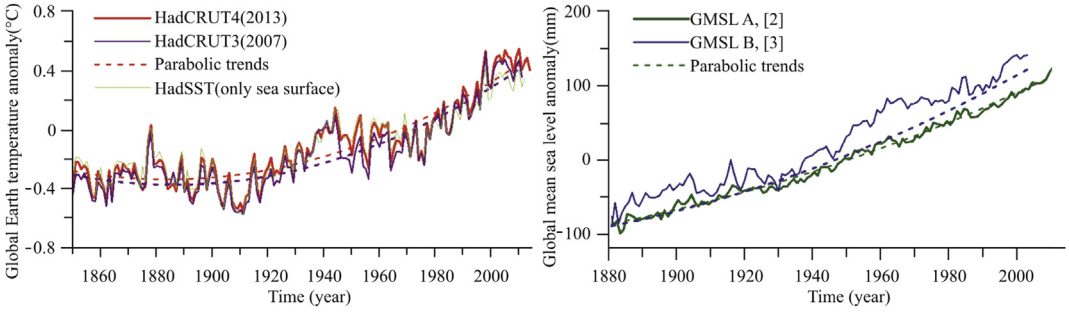

Fig. 1 – Global Earth mean temperature (HadCRUT) (left) and global mean sea level (GMSL) (right) reconstructions A [2] and B [3].

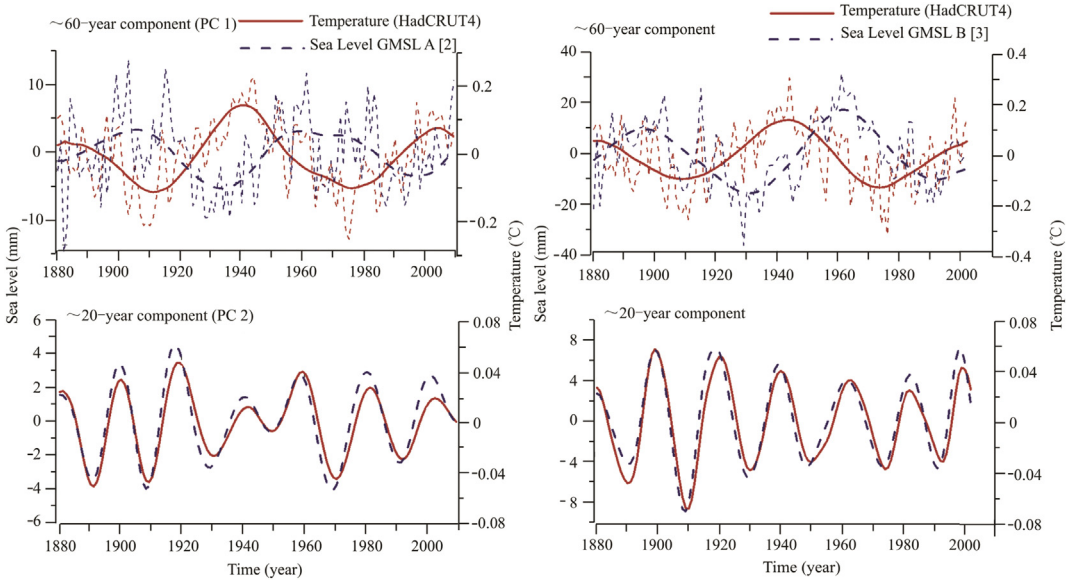

Fig. 2 – 60-year PC 1 (top) and 20-year PC 2 (bottom) oscillations in the global Earth's temperature (solid red) and sea level (dash blue), extracted from HadCRUT4 and GMSL A (left) and from HadCRUT4 and GMSL B (right) using MSSA.